

# LATE DEVONIAN CONODONTS FROM THE LUTON FORMATION, NORTHERN NEW SOUTH WALES

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(Plates v, vi)

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## *Synopsis*

A small Upper Devonian conodont fauna is described from a limestone lens in the lower part of the Luton Formation, northern New South Wales. The fauna indicates a late Fammenian (to VI) age.

## INTRODUCTION

In this article a small conodont fauna of late Fammenian age from the base of the Luton Formation, northern New South Wales, is described. The occurrence of conodonts in an impure limestone horizon in the Late Devonian rocks of this region promises to provide an accurate correlation of these strata, as well as locating more precisely the Devonian/Carboniferous boundary in northern New South Wales. To date correlation of the thick Late Devonian epiclastic sequences of the "Tamworth Trough" has been based on the few isolated occurrences of poorly preserved ammonoids (Pickett, 1960; Jenkins, 1966, 1968).

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## LOCALITY AND SIGNIFICANCE OF FAUNA

The conodonts were recovered from an impure limestone lens in the lower part of the Luton Formation,  $7\frac{1}{2}$  miles south-south-west of Horton ( $150^{\circ} 24.3' E.$ ,  $30^{\circ} 14.8' S.$ ). This falls on the Horton Map Sheet provided by McKelvey and White (1964), who also gave a summary of the stratigraphy. These writers provisionally placed the base of the Carboniferous at the base of the Luton Formation. To date no other horizons in the Luton Formation have yielded conodonts.

In all, approximately 50 kg. of sandy limestone was processed, and this yielded some 250 identifiable conodonts. The conodonts are dark brown in colour and have retained their "white matter". Most of the conodonts are broken. The fauna is dominated by platform elements, in particular *Palmatolepis gracilis*, *Polygnathus vogesi*, *Polygnathus* cf. *penmatulus* and *Pseudopolygnathus dentilineatus*. Twenty-six different species of disjunct conodont were recognized.

Ziegler (1962) has provided the standard conodont zonation of the Upper Devonian, on the basis of sections mainly in the Rhenish Schiefergebirge. This was related by Ziegler to the well-established German ammonoid succession, and has been found to apply not only in Europe, but elsewhere in the world [e.g., in N. America (Klapper, 1966) and W. Australia (Glenister and Klapper, 1966)].

The highest Fammenian zone was named the *costatus* Zone by Ziegler (1962) and divided into three on the basis of the ranges of subspecies of *Spathognathus costatus sensu* Ziegler and *Palmatolepis gonioclymeniae*. The Lower *costatus*

Zone falls in the upper part of the *Clymenia* Stufe (to V), whereas the Middle and Upper *costatus* Zones are approximately coextensive with the *Wocklumeria* Stufe (to VI).

Although it is clear that the Luton conodont fauna is that of the *costatus* Zone, in the absence of *S. costatus sensu* Ziegler and *P. gonioclymeniae* it is difficult to arrive at a more precise estimate of its position.

*Palmatolepis gracilis sigmoidalis* ranges throughout the *costatus* Zone. *Polygnathus vogesi* is said by Ziegler (1962) to range from the Middle *costatus* Zone into the *Gattendorfia* Stufe. *Pseudopolygnathus trigonicus* was given by Ziegler (1962) as occurring in the Middle and Upper *costatus* Zones, although Freyer and Zakowa (1967) have extended the range down into the Lower *costatus* Zone. *Spathognathodus aculeatus sensu* Ziegler is usually considered to occur in the Lower and Middle *costatus* Zones, but there are problems in the identification of this form species. Another platformed element in the fauna suggestive of a to VI age is *Polygnathus* sp. cf. *symmetricus*. Other elements appear to be longer ranging.

The evidence therefore favours reference of the Luton conodont fauna to the Middle *costatus* Zone, equivalent to the early *Wocklumeria* Stufe (to VI). This indicates that the Devonian-Carboniferous boundary in New South Wales is to be found in the upper part of the Luton Formation. The to VI age for the lower part of the Luton Formation lends strong support to Pedder's (1968) conclusion that the Kiah Limestone Member (with *Cymaclymenia borahensis* Pickett) of the underlying Mandowa Mudstone is of to V age.

#### SYSTEMATICS

##### Genus BRYANTODUS Bassler, 1925

*Type species*: *Bryantodus typicus* Bassler, 1925.

*Bryantodus* sp. (Pl. v, Fig. 1)

*Figured hypotype*: F10901/1.

*Remarks*: The most complete fragment of this form lacks the posterior bar. The anterior bar is arched and gently flexed, with fused, laterally compressed denticles. As far as can be ascertained, the species represented is similar to *Bryantodus typicus* Bassler (Huddle, 1968, p. 11, Pl. 3, figs. 1-15; Pl. 4, figs. 12-15).

##### Genus DIPLOPODELLA Bassler, 1925

*Type species*: *Diplopodella bilateralis* Bassler, 1925.

*Diplopodella* sp. (Pl. v, Fig. 16)

*Figured hypotype*: F10901/16.

*Remarks*: The more complete of the two available specimens lacks one lateral bar. The cusp is laterally compressed and projects posteriorly to form a short posterior bar bearing two compressed denticles. The lateral limbs are deep and bear closed spaced, fused denticles. There is no basal cavity.

##### Genus HIBBARDELLA Bassler, 1927

*Type species*: *Prioniodus angulatus* Hinde, 1879.

*Remarks*: Recent discussions of the application of the genera *Hibbardella*, *Roundya* Hass, *Ellisonia* Müller and *Diplopodella* Bassler have been given by Philip (1966), Müller and Clark (1967) and Huddle (1968), who are all in substantial agreement. Here Huddle's interpretation of these genera has been followed. More recently Rhodes *et al.* (1969, p. 111) have proposed a new subgenus *Hassognathus*, based on *Trichognathus separatus* Branson and Mehl, for similar forms in which the basal cavity is located more beneath the posterior bar. They also maintain *Roundya* as a subgenus of *Hibbardella*.

*Hibbardella* sp. (Pl. v, Fig. 3)

*Figured hypotype*: F10901/3.

*Remarks*: The single available specimen of this form has a large subquadrate cusp and a deep basal cavity. It closely resembles *Hibbardella barnettana* (Hass, 1953, p. 89, Pl. 16, figs. 8-9), the type species of *Roundya* Hass, but as all three processes are broken, no positive identification is made.

## Genus HINDEODELLA Bassler, 1925

*Type species*: *Hindeodella subtilis* Bassler, 1925.

*Hindeodella* sp. (Pl. v, Fig. 2)

*Figured hypotype*: F10901/2.

*Remarks*: Specimens of *Hindeodella* in the collection are all extremely fragmentary. It is likely that the specimen illustrated in Pl. v, Fig. 2 is referable to *H. subtilis* Bassler as interpreted by Huddle (1968, pp. 17-18). The specimen illustrated as *Hindeodella* ? sp. in Pl. v, Fig. 11 (F10901/11) is apparently a different species, and, in the strong downward deflection of the anterior bar, resembles more closely *Hindeodella alternata* Ulrich and Bassler (Huddle, 1968, pp. 15-16, Pl. 5, figs. 1, 3). As the posterior bar is missing, however, the specimen cannot be positively assigned to *Hindeodella*.

## Genus LIGONODINA Bassler, 1925

*Type species*: *Ligonodina pectinata* Ulrich and Bassler, 1926.

*Ligonodina bicurvata* Mound (Pl. v, Fig. 10)

*Ligonodina delicata* Branson and Mehl, 1934, p. 199, Pl. 14, figs. 22, 23.

*Ligonodina bicurvata* Mound, 1968, p. 489, Pl. 66, figs. 22, 30 (*q.v.* for full synonymy).

*Ligonodina beata* Rhodes, Austin and Druce, 1959, p. 135, Pl. 26, figs. 4-6*b*.

*Not Phragmodus delicatula* Branson and Mehl = *Ligonodina delicata* (Branson and Mehl).

*Figured hypotype*: F10901/10.

*Description*: This is a delicate species of *Ligonodina* with a long, gently recurved, somewhat flattened cusp continued downwards and inwards as a long anticusp. Up to about five isolated rounded denticles on anticusp; posterior bar with slender, backwardly directed, well separated, rounded denticles. Aboral surface of posterior bar marked with a longitudinal groove, which opens into the large basal cavity and is continued to the extremity of the anticusp.

*Remarks*: Mound's (*loc. cit.*) correction of the primary homonym which arose from Bergström's (1964, pp. 28-29) reference of *Phragmodus delicatus* Branson and Mehl to *Ligonodina* has priority over that of Rhodes *et al.* Ethington (1965) has noted that the *L. bicurvata* ranges from the Middle Devonian through into the Early Carboniferous.

## Genus LONCHODINA Bassler, 1925

*Type species*: *Lonchodina typicalis* Bassler, 1925.

*Lonchodina* spp. (Pl. v, Figs. 9, 14-15)

*Figured hypotypes*: F10901/9, 14, 15.

*Remarks*: A number of asymmetrical, twisted and arched bar elements are present in the collection. Three different species of *Lonchodina* appear to be represented by the illustrated specimens. Of these, that shown in Pl. v, Fig. 15 resembles closely *Lonchodina clavata* (Hinde). However, more material is necessary before positive identification can be made.

## Genus NEOPRIONIODUS Rhodes and Müller, 1956

*Type species*: *Prioniodus conjunctus* Gunnell, 1931.

*Neoprioniodus oligus* (Cooper) (Pl. VI, Fig. 14)

*Prioniodus oligus* Cooper, 1939, p. 405, Pl. 46, figs. 9–11, 63, 71; Pl. 47, figs. 20–21.

*Prioniodina oliga* (Cooper), Bischoff, 1957, pp. 47–48.

*Neoprioniodus oligus* (Cooper), Hass, 1959, p. 384, Pl. 47, fig. 3.

*Figured hypotype*: F10900/14.

*Description*: A form of *Neoprioniodus* in which the denticles of the posterior bar are strongly compressed and may be completely fused to form a deep ridge which merges with the cusp. Cusp flattened with anterior and posterior keels. Basal cavity large with a flaring inner margin.

*Remarks*: The single specimen recovered from the Luton Formation is identical with the material described by Hass (*loc. cit.*) from the Chappel Limestone of Texas. Hitherto the species appears to have been recorded only from Early Carboniferous strata.

## Genus OZARKODINA Branson and Mehl, 1933

*Type species*: *Ozarkodina typica* Branson and Mehl.

*Ozarkodina* spp. (Pl. v, Figs. 4, 12, 13)

*Figured hypotypes*: F10901/4, 12, 13.

*Remarks*: Three separate species of *Ozarkodina* appear to be present in the collection, but all of the specimens are fragmentary. The form illustrated in Pl. v, Fig. 4 resembles closely *O. macra* Branson and Mehl, whereas that shown in Pl. v, Fig. 12 is a more delicate unit, and so may be compared with *O. elegans* (Stauffer). The specimen illustrated in Pl. v, Fig. 13 has a tiny basal cavity and a poorly differentiated cusp. These characters appear to distinguish it from previously described species.

## Genus PALMATOLEPIS Ulrich and Bassler, 1926

*Type species*: *Palmatolepis perlobata* Ulrich and Bassler, 1926.

*Remarks*: Attempts to subdivide this widespread Devonian form genus (Müller, 1956; Helms, 1963) have not met with general acceptance. Although the genus is generally considered to be confined to the Late Devonian, Huddle (1968, p. 33) has suggested that his (1934) *P. minuta* (*non* Branson and Mehl) is an authentic Early Mississippian species.

*Palmatolepis gracilis* Branson and Mehl

*Palmatolepis gracilis* Branson and Mehl, 1934, p. 238, Pl. 18, figs. 2, 8 (not fig. 5); Mehl and Ziegler, 1963, pp. 200–205, Pl. 1, figs. 1–2.

*Palmatolepis* (*Deflectolepis*) *deflectens* Müller, 1956a, p. 32, Pl. 11, figs. 28–39.

*Remarks*: This species of *Palmatolepis* usually possesses a narrow platform running parallel with the carina. The platform is widest anteriorly and tapers to the posterior end. The outer margin of platform is regularly convex at the anterior end, and the inner margin forms an anterior subcircular lobe. Ziegler (1962) distinguished two subspecies, both of which occur in the Luton Formation.

*Palmatolepis gracilis gracilis* Branson and Mehl (Pl. VI, Figs. 8–10, 26–29)

*Palmatolepis gracilis* Branson and Mehl, 1934, p. 238, Pl. 18, figs. 2, 8 (not fig. 5); Wolska, 1967, p. 395, Pl. 11, figs. 1–3, 5 (not fig. 4 = *P. gracilis sigmoidalis*).

*Palmatolepis deflectens deflectens* Müller, Ziegler, 1962, p. 56, Pl. 3, figs. 17–22; Freyer in Freyer and Zakowa, 1967, pp. 114–115, Pl. 1, fig. 1; Pl. 2, figs. 3–4.

*Palmatolepis gracilis gracilis* Branson and Mehl, Klapper, 1966, p. 31, Pl. 6, fig. 3; Klapper and Glenister, 1966, pp. 814–815, Pl. 90, fig. 6 (*q.v.* for full synonymy); Druce, 1969, pp. 88–89, Pl. 17, figs. 3a–5b.

*Figured hypotypes* : F10900/8-10, 26-29.

*Description* : This subspecies of *P. gracilis* has a gently to strongly curved blade and carina. The keel is offset parallel to the margin of the inner platform lobe to form a semicircular ridge (Pl. VI, Fig. 27).

*Remarks* : Klapper (*loc. cit.*) has pointed out that in some specimens of *P. gracilis* the platform may become relatively large so that they resemble *P. gonio-clymeniae*. In this latter species, however, the posterior end is arched upwards, the carina is more sharply deflected, and this deflection takes place closer to the anterior end. The larger specimens in the Luton fauna have been previously listed as *P. gonio-clymeniae* in Pedder (1968, p. 141).

*Palmatolepis gracilis sigmoidalis* Ziegler (Pl. VI, Figs. 5-7)

*Palmatolepis deflectens sigmoidalis* Ziegler, 1962, pp. 56-57, Pl. 3, figs. 24-28.

*Palmatolepis gracilis sigmoidalis* Ziegler, Klapper, 1966, p. 31, Pl. 6, fig. 8 (*q.v.* for full synonymy); Druce, 1969, p. 89, Pl. 17, figs. 2a-b.

*Palmatolepis gracilis* Branson and Mehl, Wolska, 1967, p. 395, Pl. 11, fig. 4 (not figs. 1-3, 5 = *P. gracilis gracilis*).

*Figured hypotypes* : F10900/5-7.

*Description* : In this subspecies of *P. gracilis* the carina and platform are strongly sigmoidal.

*Remarks* : The specimens from the Luton Formation bear out Klapper's (*loc. cit.*) observation that this subspecies lacks the semicircular offset of the keel which is present in the nominate subspecies. *P. gracilis sigmoidalis* is confined to the *Spathognathodus costatus* Zone (*sensu* Ziegler, 1962) in both Europe and N. America.

#### Genus POLYGNATHUS Hinde, 1879

*Type species* : *Polygnathus dubius* Hinde, 1879.

*Polygnathus cf. pennatulus* Ulrich and Bassler (Pl. V, Figs. 23-27)

Cf. *Polygnathus pennatulus* Ulrich and Bassler, 1926, p. 45, Pl. 7, fig. 8, text-fig. 5 (7).

*Polygnathus pennatula* Ulrich and Bassler, Huddle, 1968, pp. 40-41, Pl. 15, figs. 11-12 (*q.v.* for full synonymy).

*Figured hypotypes* : F10901/23-27.

*Description* : The platform is thick and subtriangular with a high carina flanked by short, deep troughs. The unit is somewhat bowed and arched. The margins of the platform are crenulated by sharp transverse ridges. The basal cavity is relatively large, circular to ovate, usually with prominent lips.

*Remarks* : The Luton form is somewhat more laterally bowed than the specimens described by Huddle (*loc. cit.*). It is therefore only compared with *P. pennatulus*. *Polygnathus bischoffi* Rhodes *et al.* (1969, pp. 184-185, Pl. 13, figs. 8a-11c) is a species very close to, if not identical with *P. pennatulus*.

*Polygnathus cf. symmetricus* Branson (Pl. V, Figs. 17-18)

Cf. *Polygnathus symmetrica* Branson, 1934, p. 310, Pl. 25, fig. 11; Klapper, 1966, p. 21, Pl. 4, figs. 7, 9; Pl. 6, figs. 1, 5 (*q.v.* for full synonymy).

*Figured hypotype* : F10901/17.

*Remarks* : Although the illustrated specimen has a nearly bilaterally symmetrical platform with the anterolateral margins only slightly upturned, its posterior end is attenuated. It is therefore intermediate between *P. symmetricus* and *P. longiposticus* Branson and Mehl (Klapper, 1966, pp. 20-21). Klapper (*loc. cit.*) noted that many specimens in his material also were intermediate between these two species.

*P. symmetricus* ranges from to VI strata (Bischoff, 1956) to *cu* II strata (Bischoff and Ziegler, 1956).

*Polygnathus vogesi* Ziegler (Pl. v, Figs. 8, 19–22)

*Polygnathus vogesi* Ziegler, 1962, pp. 94–95, Pl. 11, figs. 5–7.

*Polygnathus styriaca* Ziegler in Flügel and Ziegler, 1957, pp. 47–48, Pl. 1, fig. 11 (not figs. 12–13 = *styriacus*).

*Polygnathus* cf. *styriaca* Ziegler, Voges, 1959, p. 294, Pl. 34, figs. 36–41.

*Figured hypotypes*: F10901/8, 19–22.

*Description*: This species of *Polygnathus* has a thin, upwardly arched, lanceolate platform. The platform is ornamented with two distinct denticulate ridges which run from the anterolateral corners to the central part of the platform. The anterior margin of the platform is deeply trough-shaped and grooves usually are present also posterior to the radiating ridges. Aboral surface has a tiny basal cavity mounted on the prominent keel. The lower surface may possess grooves complementary to the radiating ridges of the oral surface.

*Remarks*: This species closely resembles *P. communis carinus* Hass, 1959. Voges (*loc. cit.*) has already noted that in this latter form the basal cavity is distinctly larger, the radiating ridges are less regular, and the anterior end of the platform less sunken. The Australian specimens closely resemble those described by Voges. The specimens on which Ziegler (*loc. cit.*) based the species tend to have a somewhat broader platform and a suggestion of nodose ornament on the posterior part of the platform.

In Europe *P. vogesi* ranges from the Middle *costatus* Zone (to V?–to VI) (Ziegler, 1962) into *cu* I strata.

*Polygnathus* sp. (Pl. v, Figs. 5–7)

*Figured hypotypes*: F10901/5, 7.

*Remarks*: This species resembles most closely *Polygnathus obliquicostatus* Ziegler (1962, pp. 92–93, Pl. 11, figs. 8–12; Klapper, 1966, p. 22, Pl. 6, figs. 2, 4). In its upper surface morphology it differs most notably in that the transverse ridges of the inner platform are not so oblique to the carina, and the carina extends to the posterior end of the platform. A keel is present throughout the length of the unit.

In the possession of a rostrum, this species, like *P. obliquicostatus*, resembles species of *Siphonodella*. However, Klapper (1966), in distinguishing *Siphonodella* and *Polygnathus*, has emphasized that the latter genus has a raised keel which runs the length of the platform and is interrupted only by the basal cavity. In contrast, the keel of *Siphonodella* is either absent or is represented by a thin groove which runs some distance posterior to the basal cavity.

This species, which is abundantly represented in material of Early Carboniferous age from Queensland, will be described in detail elsewhere.

Genus PSEUDOPOLYGNATHUS Branson and Mehl, 1934

*Type species*: *Pseudopolygnathus primus* Branson and Mehl.

*Pseudopolygnathus dentilineatus* Branson (Pl. VI, Figs. 23–25)

*Pseudopolygnathus dentilineata* Branson, 1934, p. 317, Pl. 26, fig. 22; Bischoff, 1957, pp. 50–51, Pl. 4, figs. 29–32, 34; Voges, 1959, pp. 300–301, Pl. 34, figs. 49–50; Klapper, 1966, pp. 14–15, Pl. 5, figs. 10–11 (*q.v.* for full synonymy); van Adrichem Boogaert, 1966, p. 185, Pl. 3, fig. 8; Canis, 1968, p. 546, Pl. 73, figs. 10, 29–31.

*Pseudopolygnathus dentilineatus* Branson, Rhodes *et al.*, 1969, pp. 208–209, Pl. 5, figs. 9a–13c; Pl. 6, figs. 8a–c.

*Pseudopolygnathus vogesi* Rhodes *et al.*, 1969, pp. 216–217, Pl. 5, figs. 1a-c, 3a-c, 5a–8; Druce, 1969, pp. 114–115, Pl. 36, figs. 1a–7b.

*Figured hypotypes*: F10900/23–25.

*Description*: The platform is usually narrow and pointed and ornamented with coarse nodes or irregular transverse ridges. The right side of the platform extends further toward the anterior end than does the left side. Basal cavity large, covering the entire width of the platform, and usually has flaring lips.

*Remarks*: Rhodes *et al.* (1969), on the basis of the Carboniferous conodont sequence of Britain, postulated three successive independent developments of *Pseudopolygnathus* from species of *Spathognathodus* with double rows of denticles. The first development included forms which they named as *P. vogesi* and considered as homeomorphs of *P. dentilineatus*. This latter name was restricted to a form postulated as originating from *Spathognathodus* as a later time. No morphological characters serve to distinguish these species. Until such time as a similar discontinuity in the occurrence of species of *Pseudopolygnathus* is established in N. America (e.g. in the Hannibal Formation in Missouri) it seems premature to follow this division.

Forms of the morphology of *P. dentilineatus* have a total range from the Upper *styriacus* Zone (to V) to the Z zone of the British Avonian (? *cu* II beta/gamma).

*Pseudopolygnathus trigonicus* Ziegler (Pl. VI, Figs. 16–19)

*Pseudopolygnathus trigonica* Ziegler, 1962, pp. 101–102, Pl. 12, figs. 8–13; Freyer and Zakowa, 1967, pp. 109–110.

*Figured hypotypes*: F10900/16–19.

*Description*: This species of *Pseudopolygnathus* has a thin, arched, triangular platform and a long high blade. The platform is ornamented with nodes, the largest of which form secondary carinae which run to the anterolateral margins of the platform. The inner platform usually has a secondary lobe. The aboral surface with a central pit and a well-defined posterior keel. Arising from the keel are two ridges, one of which runs to the lateral extremity of the outer platform and the other to the secondary lobe of the inner platform.

*Remarks*: The lateral ridges of the aboral surface delineate a shallow asymmetrical depression beneath the anterior part of the platform. This is interpreted as the basal cavity, and, as a consequence, the species was referred by Ziegler to *Pseudopolygnathus*. The species cannot be located here without some reservation as its upper surface morphology, however, is more akin to that of *Ancyrodella*.

Ziegler (1962) originally gave the range of *P. trigonicus* as Middle to Upper *costatus* Zone. Freyer and Zakowa (*loc. cit.*) have extended its range to the Lower *costatus* Zone in Poland.

Genus SPATHOGNATHODUS Branson and Mehl, 1941

*Type species*: *Ctenognathus purchisoni* Pander, 1856.

*Spathognathus aculeatus* (Branson and Mehl) (Pl. VI, Figs. 12, 20)

*Spathodus aculeatus* Branson and Mehl, 1934, pp. 186–187, Pl. 17, figs. 11, 14.

*Spathognathodus aculeatus* (Branson and Mehl, Ziegler, 1962, pp. 105–106, Pl. 13, figs. 27–36; Bouckaert and Ziegler, 1965, Pl. 5, figs. 1–4; Klapper, 1966, p. 24, Pl. 6, figs. 15–17; Glenister and Klapper, 1966, pp. 835–836, Pl. 95, fig. 11 (*q.v.* for complete synonymy); van Adrichem Boogaert, 1966, p. 186, Pl. 3, fig. 19; Freyer and Zakowa, 1967, p. 120, Pl. 1, fig. 12; Wolska, 1967, p. 425, Pl. 19, figs. 4–8.

*Spathognathodus* cf. *S. aculeatus* (Branson and Mehl), Druce, 1969, p. 124, Pl. 27, figs. 5a-c.

*Figured hypotypes*: F10900/12, 20.

*Remarks*: The Luton specimens are all broken but are certainly referable to *S. aculeatus*, as generally interpreted. This form species usually has three to five lateral denticles joined to those of the blade by transverse ridges in the region of the basal cavity, which is mounted at midlength and is wide and circular.

Recently Rhodes *et al.* (1969, p. 236) stated that "forms described from Germany and identified by Ziegler (1961) and other authors may be distinct from *S. aculeatus* and are probably a new species". As no basis for such a separation is apparent, here Ziegler's (1962) and Klapper's (1966) interpretation of the species is followed and the specimens from the Bonaparte Gulf Basin, compared by Druce with this species, are included in it.

Rhodes *et al.* (*op. cit.*) also describe a new species, *S. plumulus*, which differs from *S. aculeatus* in the possession of high, crested denticles at the anterior end of the unit.

As interpreted here, the species in Germany ranges from the middle Lower *costatus* Zone to the Middle *costatus* Zone (i.e. the boundary of to V and VI) to to VI alpha (Ziegler, 1962). It has a similar range in Spain (Higgins *et al.*, 1964; van Adrichem Bouckaert, 1966), Belgium (Bouckaert and Ziegler, 1965), Poland (Freyer and Zakowa, 1967; Wolska, 1967), the Mississippi Valley (Collinson, Scott and Rexroad, 1962, pp. 17, 18), the Canning Basin, Western Australia (Glenister and Klapper, 1966) and the Bonaparte Gulf Basin, Western Australia (Druce, 1969). Canis's (1968) record of this species from the Bachelor Formation of Missouri of *cu* II alpha age is based on *S. antiposicornis* Scott.

*Spathognathus crassidentatus* (Branson and Mehl) (Pl. VI, Fig. 1)

*Spathodus crassidentatus* Branson and Mehl, 1934, p. 276, Pl. 22, fig. 17.

*Spathognathodus crassidentatus* (Branson and Mehl), Klapper, 1966, p. 23, Pl. 5, figs. 15–17 (*q.v.* for full synonymy); Canis, 1968, pp. 552–553, Pl. 74, fig. 29; Rhodes *et al.*, 1969, pp. 226–227, Pl. 3, figs. 1a–4b; Druce, 1969, pp. 127–128, Pl. 27, figs. 2a–3b.

*Figured hypotype*: F10900/1.

*Description*: This is a bladed unit, slightly arched in profile, sloping downwards to its posterior end. The anterior end has two enlarged denticles, markedly wider and higher than the remainder. The basal cavity extends from somewhat in front of midlength to near the posterior end; its greatest width is at the rounded anterior margin, whence it tapers to the posterior end.

*Remarks*: The Luton specimens agree closely with the paucidenticulate forms described by Klapper (*loc. cit.*) rather than, for example, those illustrated by Rhodes *et al.* (*loc. cit.*). Most authors, however, have commented on the wide range of variation in this species.

Hitherto, *S. crassidentatus* has been recorded only from Early Carboniferous strata in N. America (Klapper, 1966; Canis, 1968), Europe (Rhodes *et al.*, 1969), and Australia (Druce, 1969).

*Spathognathodus praelongus* Cooper (Pl. VI, Fig. 21)

*Spathognathodus praelongus* Cooper in Cooper and Sloss, 1943, p. 175, Pl. 28, fig. 14; Klapper, 1966, p. 24, Pl. 6, fig. 23 (*q.v.* for full synonymy).

*Figured hypotype*: F10900/21.

*Remarks*: This is a bladed species of *Spathognathodus* with the posterior end of unit incurved. A slightly enlarged denticle present above the basal cavity, which is marked toward the posterior end of unit. Klapper (*loc. cit.*) gives the range of this species as Late Devonian in N. America.



*Spathognathodus* sp. A (Pl. VI, Figs. 11-12)

*Figured hypotypes* : F10900/11, 12.

*Remarks* : This is a bladed form of *Spathognathodus* in which the unit tends to be incurved. In profile the unit is arched. The basal cavity is symmetrical, widest at its anterior end and extending to near the posterior end of the unit. All specimens are badly broken, so that the species represented cannot be positively identified. It appears to be close to Late Devonian forms identified as *S. stabilis* (Branson and Mehl) (e.g. Klapper, 1966, Pl. 5, fig. 6).

*Spathognathodus* sp. B (Pl. VI, Figs. 2-4)

*Figured hypotypes* : F10900/2-4.

*Remarks* : This is a massive species of *Spathognathodus* with regular denticulation and a prominent asymmetric basal cavity mounted toward the posterior end of the unit. Nodes may be present on the upper surface of the lobes of the basal cavity. The form apparently bears little relationship to previously described Upper Devonian species.

## Genus SYNPRIONIODINA Bassler, 1925

*Type species* : *Synprioniodina alternata* Bassler, 1925.

*Synprioniodina* sp. (Pl. VI, Figs. 13, 15)

*Figured hypotypes* : F10900/13, 15.

*Remarks* : In all of the available specimens the posterior bar is missing, so that positive identification is not possible. The cusp and the denticulated anticusp compare closely with those of *Synprioniodina alternata* Bassler (Huddle, 1968, pp. 45-46, Pl. 6, figs. 3-5, 12).

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## EXPLANATION OF PLATES

All figures  $\times 40$  and specimens registered in the Palaeontological Collection of the University of New England.

## PLATE V

- Fig. 1. *Bryantodus* sp. Lateral view of F10901/1.
- Fig. 2. *Hindeodella* sp. Inner view of F10901/2.
- Fig. 3. *Hibbardella* sp. Posterior view of F10901/3.
- Fig. 4. *Ozarkodina* sp. Lateral view of F10901/4.
- Figs. 5-7. *Polygnathus* sp. 5, Aboral view of F10901/5. 6, Oral view of same specimen. 7, Oral view of F10901/7.
- Figs. 8, 19-22. *Polygnathus vogesi* Ziegler. 8, Lateral view of F10901/8. 19, Oral view of F10901/19. 20, Aboral view of F10901/20. 21, Oral view of F10901/21. 22, Oral view of F10901/22.
- Fig. 9. *Lonchodina* sp. Inner view of F10901/9.
- Fig. 10. *Ligonodina bicurvata* Mound. Inner view of F10901/10.
- Fig. 11. *Hindeodella* ? sp. Inner view of F10901/11.
- Fig. 12. *Ozarkodina* sp. Lateral view of F10901/12.

- Fig. 13. *Ozarkodina* sp. Lateral view of F10901/13.  
 Fig. 14. *Lonchodina* sp. Inner view of F10901/14.  
 Fig. 15. *Lonchodina* sp. Inner view of F10901/15.  
 Fig. 16. *Diplopodella* sp. Posterior view of F10901/16.  
 Figs. 17-18. *Polygnathus* cf. *symmetricus* Branson. 17, Lateral view of F10901/17. 18, Oblique oral view of same specimen.  
 Figs. 23-27. *Polygnathus* cf. *pennatulus* Bassler. 23, Aboral view of F10901/23. 24, Aboral view of F10901/24. 25, Oblique oral view of F10901/25. 26, Aboral view of F10901/26. 27, Oblique oral view of F10901/27.

## PLATE VI

- Fig. 1. *Spathognathodus crassidentatus* (Branson and Mehl). Lateral view of F10900/1.  
 Figs. 2-4. *Spathognathodus* sp. B. 2, Lateral view of F10900/2. 3, Lateral view of F10900/3. 4, Oral view of F10900/4.  
 Figs. 5-7. *Palmatolepis gracilis sigmoidalis* Ziegler. 5, Oblique oral view of F10900/5. 6, Oblique oral view of F10900/6. 7, Oblique oral view of F10900/7.  
 Figs. 8-10, 26-29. *Palmatolepis gracilis gracilis* Branson and Mehl. 8, Oblique oral view of F10900/8. 9, Oral view of F10900/9. 10, Oral view of F10900/10. 26, Oral view of F10900/26. 27, Aboral view of F10900/27, a broken platform. 28, Oral view of F10900-28, a complete specimen with a fully developed platform. 29, Oral view of F10900/29.  
 Figs. 11, 22. *Spathognathodus* sp. A (Branson and Mehl). 11, Lateral view of F10900/11. 22, Lateral view of F10900/22.  
 Figs. 12, 20. *Spathognathodus aculeatus* (Branson and Mehl). 12, Aboral view of F10900/12. 20, Oral view of F10900/20.  
 Figs. 13, 15. *Synprioniodina* sp. 13, Inner view of F10900/13. 15, Inner view of F10900/15.  
 Fig. 14. *Neoprioniodus oligus* (Cooper). Inner view of F10900/14.  
 Figs. 16-19. *Pseudopolygnathus trigonicus* Ziegler. 16, Oral view of F10900/16. 17, Lateral view of F10900/17. 18, Oral view of F10900/18. 19, Aboral view of F10900/19.  
 Fig. 21. *Spathognathodus praelongus* Cooper. Lateral view of F10900/21.  
 Figs. 23-25. *Pseudopolygnathus dentilineatus* Branson. 23, Oral view of F10900/23. 24, Oral view of F10900/24. 25, Oral view of F10900/25.



